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The organizational factors in memory relevant to learning medical diagnosis terms are discussed in this paper. Two hypotheses are tested: that the type of list organization will affect total recall; and that the type of curriculum and year in school will affect the organization of recall. Ninety-six second and third year medical students from two different curricula were given five trials at memorizing a list of medical terms which were organized according to three different schemes, according to diseases, according to organ systems, and randomly. The results of the data analysis indicated that none of the hypotheses tested were confirmed. There was an overall tendency of the subjects to prefer the use of the organ systems category scheme. (Author/MKM)

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ABSTRACT

The organizational factors in memory relevant to learning medical diagnosis are discussed. Hypotheses that type of list organization will affect total recall, and that type of curriculum and year in school will affect organization of recall are tested. Ninety-six second and third year medical students from two different curricula were given 5 trials at memorizing a list of medical terms organized according to three different schemes, and recall the list in a free recall setting. Results show that none of the hypotheses tested were confirmed, and that there is an overall tendency to use one organizational scheme.

Orgnization of Free Recall
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Introduction

Memory factors (particularly organization) play an important role in higher order learning, particularly learning related to problem solving in highly specialized content areas. This is the first of three studies which attempt to demonstrate a relationship between memory organization and problem solving in one highly specialized area--the area of medical diagnosis. How does the expert physician organize the volume of clinical information he possesses to make it maximally accessible during the problem solving process? In this study those organizational factors which seem to have the strongest relationship to diagnostic problem solving are discussed. In the two subsequent studies the nature of this relationship is further developed and implications for teaching problem solving in medical diagnosis as well as in other areas are discussed.

Statement of Problem

Traditionally medical school curricula are organized in three different ways: by academic discipline, by organ systems and by problem orientation. The last two types of organization are most closely related to diagnostic problem solving, since patients present with problems, and problems occur in organ systems. If indeed the organization of the medical curriculum affects the students' learning organization, one might think that students in the former curriculum would tend to adopt an organ centered organization whereas those in the latter curriculum might adopt an organization centered around problems or diseases. A hypothetical model (1,2,3) for the experienced physician's memory structure centers around diseases. Comparing the curricular structures to the structure of the experienced physician suggests that at some time the student physician must make a shift toward a disease centered organization. It would seem that the student in the systems oriented curriculum would have to make a more significant shift than the one in the problem centered curriculum.

This study seeks to explicate the nature of the student's natural memory organization, the nature of the effect of a given curriculum on the student's memory organization, and the presence of a shift to the disease centered organization as the student gains clinical experience.

Specifically the hypotheses tested are:

1. Lists of diagnostic cues grouped according to disease entities and organ systems will be more readily recalled than randomly ordered lists.

2. Students in an organ systems curriculum will tend to cluster their recall around systems whereas those in a problem oriented curriculum will tend to cluster their recall around diseases.

3. There will be a shift from organ systems clustering a disease clustering as students progress through medical school.

Background

Recently several investigators have argued that a consideration of memory factors is of particular importance in theorizing about problem solving in general (4,5) and medical diagnosis in particular (6,7). Schwartz and Simon state their positions as follows:

> "...the way a physician organizes or structures his medical knowledge will influence almost every phase of his diagnostic behavior. That is, different organizations of medical knowledge would lead to different diagnostic possibilities as well as variations in the order in which possibilities are considered. Hence, it becomes critical to determine the ways in which physicians actually organize medical knowledge."

Results of studies at Michigan State University (1,3) suggest the model for the physician's organization of knowledge. Elstein et al (1) and Sprafka and Elstein (2) for example have suggested a model of inquiry which points to early generation of diagnostic hypotheses, acquisition of cues, interpretation of these cues in the light of hypotheses and evaluation of the viability of hypotheses throughout the problem solving episode. Furthermore Allal (3) has found that not only are hypotheses generated very early in the diagnostic process but there seems to be a significant amount of hierarchical organization (from general disease categories to specific disease entities) of those hypotheses which are generated.

In summary, though little research is available in this area, that which exists suggests that a) memory organization plays an important role in the diagnostic process, and b) that the memory of experienced physicians is disease centered.

Methods of Procedure

Materials: A list of 42 medical terms (signs and symptoms of diseases) was created with the assistance of a physician. The terms were then grouped into three different list organizations: according to diseases, according to organ systems, and randomly. Each group contained between four and six terms. The random groups were created by arranging the terms in random order and randomly assigning 4,5, or 6 terms to a group. The lists were presented as two typed single spaced columns. Booklets of 5 trial lists alternated with recall pages containing 42 blank lines were created. The order of the categories and the order of terms within each category was different on each trial list. Three different page orders were used for each treatment.

Design: A 2x2x3 factorial design was used with 4 repeated measures in one instance (total recall) and three repeated measures in the other (clustering). The factors are: two schools (College of Human Medicine with a problem oriented curriculum and College of Osteopathic Medicine with an organ systems curriculum; two stages in school (year two which is primarily didactic and year three which is primarily clinical/practical); three list organizations (disease grouping, organ systems grouping, and random). Each subject had five trials at memorizing the list of terms yielding five measures per subject. In the total recall

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analysis all five measures were used. In the clustering analysis only the last four measures were used. The first measure was dropped since it was extremely erratic and was not representative of the subjects' performance on subsequent measures.

Subjects: Subjects were volunteers from the second and third year classes of the College of Human Medicine and the College of Osteopathic Medicine. Subjects were paid for their participation in the study. A total of 96 subjects participated in the study with eight subjects being assigned to each of 12 treatment groups.

Procedure: The study was conducted about midway through the school year. Subjects were randomly assigned to experimental treatments. Each subject received a booklet and was instructed that he would be given five opportunities to memorize a list of medical terms, and after each opportunity would be asked to write as many terms as he could recall in any order he wished. At each trial subjects were given two minutes to study the list and five minutes to recall. Recall protocols were then scored for total recall and clustering. Clustering scores were calculated using the procedure outlined by Roenker, Thompson, and Brown (8). Clustering according to disease and systems categories was calculated for all subjects. Clustering according to random categories was determined for half of the subjects but was extremely low, so was not calculated for all subjects. Overlap between disease categories and systems categories was seen to be a potential confounding variable. The degree of overlap between these two categorization schemes was assessed by generating 5 sets of perfect clustering scores on the disease dimension and calculating clustering scores for them on the systems dimension. The resulting systems scores ranged from -.279 to .192 with a mean of .032 which is hardly better than chance. The set of total recall scores and the sets of clustering scores for systems and disease organization were then each submitted to a three way ANOVA with repeated measures.

Results and Conclusions

1. The first hypothesis could have been confirmed by a significant main effect on the organization dimension for total recall. No such effect was found. There was a predictable main effect for trials, $F(1,84)^{*}=1591.36$, $p<.01$.

2. The second hypothesis could have been confirmed if systems clustering had showed main effects for type of school with Osteopathic Medicine students doing significantly better on systems clustering and Human Medicine students doing significantly better on disease clustering. These effects did not occur.

3. The last hypothesis would have been confirmed by a significant effect for school year on both systems and disease clustering scores. The effect on systems clustering scores would have shown second year students doing better than third year students. On disease clustering the third year students should have done better than second year students. These effects did not occur.

*Degrees of freedom were assigned using the procedure recommended by Box (9) for testing significance of effects in repeated measures designs.

4. List organization had a significant effect on both disease clustering, and systems clustering, $F(2,95)=22.48$, $p < .01$ and $F(2,95)=26.63$, $p < .01$ respectively. Subjects who studied lists organized around diseases tended to cluster their recall more around diseases than around systems. Subjects who studied lists organized around systems tended to cluster their recall more around systems than around diseases.

5. There was an overall effect favoring systems clustering, $t(383)= -12.98$, $p < .001$. Regardless of the way in which the stimulus list was organized, and regardless of what curriculum or what year subjects were in, they tended to favor the systems organization for recall.

From these results one may conclude that:

1. Organizing lists of stimulus items in ways which would appear to interact optimally with a natural organization does not produce better overall recall in subjects at this stage of their medical training.

2. The organization of the curriculum in which a student is placed, whether around problems or organ systems, apparently has no enduring effect on the way in which he organizes his storage of information.

3. There is apparently no shift from a natural organ systems organization to a natural disease organization as students progress from midway through the didactic second year to midway through the clinical third year.

4. There is apparently a natural tendency for students in either type of curriculum at both of these stages of their medical training to favor a systems organization for medical terms. This can be somewhat affected by the organization of stimulus lists, but is not completely cancelled.

Educational and scientific significance

These results have implications for the training of medical students in particular, as well as teaching and learning in other problem solving areas. Although controversy continues over the best ways to organize curricula, medical or otherwise, the results found here would suggest that the organization of the curriculum may make little or no difference. Students in a curriculum will organize material in a way which is most comfortable for them. Although the overriding tendency is to favor the systems organization, thus suggesting the appropriateness of the systems curriculum, this suggestion is not borne out by the specific results relevant to the two curricula. This study raises several methodological questions which must be answered before any conclusions may be reached. On the one hand, would a different approach to analysis clarify the relation between results 4 and 5, and indicate under what circumstances the stimulus lists gain control, and where the tendency to use the natural organization predominated? On the other hand, would the systems organization be maintained if the stimulus materials were redesigned to make the list organization more obvious? Secondly, would the tendency to organize around systems be maintained if the disease entities were associated with patient names? And, last, how is the student's organization of material affected by stimulus materials which more closely resemble the case records he is expected to deal with in the real world? The second and third experiments in this series examine these questions.

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